

Spring 2015

The effects of instructional strategies on adherence to a flexibility program and physiological outcomes

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Graham, Taylor M., "The effects of instructional strategies on adherence to a flexibility program and physiological outcomes" (2015). *Honors Research Projects*. 75.

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The effects of instructional strategies on adherence to a flexibility program and physiological outcomes

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Honors Research Project

Submitted to

The Honors College

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ABSTRACT

Health care professionals construct exercise prescriptions for clients and patients to complete on their own. Exercise specialists, physical therapists, occupational therapists, and exercise physiologists are all considered health care professionals for this study. Furthermore, the importance of flexibility and stretching is commonly overlooked. The purpose of this research study was to compare whether or not different instructional techniques affect adherence to a stretching routine, and if followed were improvements gained in quadriceps and hamstring flexibility. Thirty-one students from The University of Akron between the ages of 18 and 37 with an average height of 66.7 inches and average weight of 163 pounds participated in the study. The ACSM recommended sit-and-reach protocol and modified Thomas test were used to measure hamstring and quadriceps flexibility prior to and following the study. Participants were asked to complete a four-week program consisting of the completion of six yoga based stretching exercises at a minimum frequency of twice per week. The demonstration group met with researchers in the exercise physiology lab at The University of Akron, the written group completed the program on their own without instruction, but aided by a brochure, and the control continued their daily lives as normal. Results revealed no significant difference between any of the three groups for improvements in hamstring flexibility as measured by the sit and reach test. Furthermore, subject adherence showed no correlation to gains in hamstring flexibility. However, when examining the mean gains within each group, the experimental group showed significant improvements ($p= 0.03$) in hamstring flexibility, as did the control ($p= 0.05$). As hypothesized, the experimental or demonstrational group showed the greatest gains in hamstring flexibility (3.07 cm), followed by the control group (2.47 cm) and written group (1.39 cm).

INTRODUCTION

It is very common for health care professionals to prescribe exercise to patients and clients who are seeking injury prevention, disease prevention, or attempting to obtain health goals prior to diagnosis. These individuals are usually given a recommended program and then asked to complete exercises on their own, without the oversight from a health care professional. Patients who live an active lifestyle and have previously allotted time in their lives for physical activity have a knowledge base regarding exercise. However, this is not necessarily always the case and there are many individuals who would hear the term “single leg deadlift” and believe it’s a foreign language. The health care professionals prescribing exercise to patients and clients are responsible for verbally explaining, providing pictures and written explanations, and also demonstration of exercises, if needed. Furthermore, health care professionals must work to utilize effective instructional techniques to ensure that a client can properly perform exercises efficiently, effectively and safely.

There are many different types of instructional techniques. One can explain exercises verbally, which typically describes what would be used at an office visit with a doctor. Additionally, packets or brochures and instructions can be given that include written instructions and also pictures which commonly used in a physical therapy setting when a patient receives a home exercise program. Also, an instructional strategy based on a one-on-one approach can be used to provide supervision, demonstrations, in personal explanations, and also feedback on patients’ performance.

Currently, there is research that compares the effects of home based programs, pamphlets or brochures, and supervised exercise as a means to test adherence to an exercise program, as well as the effectiveness of the exercise performed. The most commonly researched exercise is aerobic and resistance training with regards to both exercise adherence and effectiveness. It is evident that these are the two most commonly utilized forms of exercise throughout the

population. However, there is presently limited information concerning the relationship between instructional strategies and the adherence to a flexibility program that then attempts to further discover the improvements gained in hamstring and quadriceps flexibility if the program is followed by the individual. The purpose of this research study is to compare whether or not different instructional techniques affect adherence to a stretching routine, and if followed were improvements gained in quadriceps and hamstring flexibility. We hypothesize that a combined approach of written, verbal, and demonstrational techniques will elicit greater improvements in quadriceps and hamstring flexibility and exercise adherence than those receiving only written instructions.

LITERATURE REVIEW: Instructional Methods

Patient adherence to an exercise prescription or therapy program is an essential component needed in order to produce positive results. The patient or client must recognize and

understand the exercise, perform the exercise effectively, and routinely perform and execute the exercise prescription (Gupta, 2012). According to Gupta, research suggests that 65% of patients are non-adherent to some portion of a physical therapy program. Although it is believed that many factors contribute to the lack of adherence, it is evident that sufficiently learning the exercise program in its entirety is an essential characteristic for physiological improvements (2012). There are many methods of instruction that are utilized in the world of health professionals including verbal explanation of exercise, handouts of information with written and illustrated instructions, and also a supervised or a demonstrational approach where patients are given explanations, feedback, and visual examples of an exercise.

Written materials which are given to patients and clients as handouts have evident advantages and disadvantages. It is common for handouts, which explain exercises and therapy instructions, to be used in a physical therapy setting in order to supplement one on one interaction with a therapist (Reo, 2004). Brochures and handouts are found to be cost effective and time efficient in order to share information with a large population in a relatively simple manner. This method of instruction provides information that is consistent, reusable, portable, and easily distributed (Bernier, 1993). Friedrich conducted a study examining the effectiveness of a handout for patients experiencing low back and neck pain. Results revealed that direct communication is more effective than information given to patients without explanation (1996). In other words, a patient's adherence to exercise, as well as their likelihood of performing the exercises correctly depends on direction communication from a health care professional who provides explanations of the information given. A study conducted by Gupta and associates found that the use of inexpensive handouts versus video recordings were equally effective methods of instruction for children, exposing that expensive technology does not necessarily elicit greater learning (2012).

When a patient is completing exercises at home, it is most effective if the individual has access to information that provides cues and pictures regarding recommended exercises to be completed. Jackson (1994) conducted a study examining exercise adherence through use of brochures. Two groups received information from their physician consisting of general information about low back pain, treatment, and an explanation for the exercise program. The group that received the brochure including relevant cues referencing to the patients' physician, showed greater overall exercise adherence. Furthermore, Jackson found that there was no difference in exercise adherence between the control group and the group receiving a brochure lacking relevant cues (1994). Therefore, this study expresses the importance of relevant cues and references to information previously provided by a patients' physician. Through the use of pamphlets and handouts, information is accessible to patients at all times, which deems important when one third of patients either misunderstand or forget information expressed verbally (Ley, 1984). Unfortunately, not all patients and clients seeking advice from a health care provider possess similar academic and literacy skills. Therefore, written materials provided by a physical therapist may not be comprehensible to all patients.

A more comprehensive form of instructional intervention is a demonstrational supervised approach, which includes verbal explanations, visual demonstrations, and constructive feedback. According to Friedrich (1996), supervised exercise provides enhanced safety, clear instruction, and greater exercise adherence. Higher levels of motivation and immediate feedback resulted in increased patient adherence to an exercise program. Friedrich (1996) tested the effectiveness of therapist supervision versus brochure usage for an exercise program aiming to overcome back and neck pain. Patients who were supervised by the physical therapist experienced much more favorable outcomes in both muscle status and pain relief. The relationship and rapport created between a physical therapist and patient are developed as result of personal interaction.

Friedrich claims that this relationship enhances the quality of the exercise performed, patients' motivation, as well as overall adherence to the exercise program (1996). Also, the supervision aspect of the one on one approach increases the likelihood of the patient using proper form, frequency at which exercises are performed, and limits further injuries. Furthermore, a study involving the use of pamphlets and supervised exercise for treating neck pain related to computer use showed that the group participating in supervised exercise experienced greater pain reduction as compared to the group receiving merely a pamphlet as guidance (Taheri, 2012). The findings of these studies suggest that the use of supervised exercise, by a health care professional, produces greater reduction in pain, as well as higher quality and safer exercise practices that result in increased exercise adherence.

Instructional methods in the form of supervision or demonstration by a therapist or health professional elicit continual and immediate feedback. Exercise adherence is increased when feedback is implemented into an intervention (Shakudo, 2009). Roemmich (2004) states that countries other than Japan have found success in using immediate feedback as an intervention strategy to improve adherence to exercise. Therefore, Shakudo's study revealed that in Japan, the use of immediate, frequent, and constructive feedback improved exercise adherence. These studies suggest that the use of feedback by physical therapist and other health care professionals may improve adherence to an assigned exercise program, especially if this method is utilized in person and frequently. Furthermore, adults possess the cognitive and memory skills such as selective attention and speed an increased speed of information processing which are necessary to use and obtain feedback (Gupta, 2012). According to Reo (2004), feedback is a necessary and critical element needed in order to properly learn a motor skill. Another study examining the effectiveness of different types of feedback when throwing with the non dominant arm revealed that feedback stating transitional information about corrections to be made as well as using cues

to understand the most important aspects of a movement where more beneficial than feedback regarding distance thrown (Kernodle, 1992). As a result, it is evident that the use of instructional feedback can work to improve exercise safety and frequency.

LITERATURE REVIEW: Hamstring Flexibility

Flexibility is an essential, although sometimes ignored, aspect of any exercise prescription or exercise program. Flexibility is defined as the ability of a muscle to lengthen and allow for one joint, or more than one joint, to move through a range of motion (Pescatello, 2014). According the American College of Sports Medicine (ACSM), maintaining adequate levels of flexibility facilitates proper bodily movement (Ehrman, 2013). Furthermore, distensibility of the joint capsule, muscle viscosity, an appropriate warm-up prior to stretching, as well as compliance

of tendons and ligaments are all factors that determine an individual's flexibility (Pescatello, 2014). Limited or impaired hamstring flexibility can lead to spinal disorders including thoracic hyperkyphosis, spondylolysis, disc herniation, change in lumbopelvic rhythm, and induce low back pain (Mayorga-Vega, 2014). In addition to spinal disorders, tight hamstrings can lead to muscle pain, decreased range of motion (ROM), musculoskeletal injuries, posture and gait problems, and increase fall risk in elderly individuals (Adegoke, 2012).

There are many different methods used to measure flexibility and range of motion including goniometers, electrogoniometers, the Leighton flexometer, inclinometers, and tape measurements. Quadriceps flexibility is an example of a specific muscle that can be measured using a goniometer, a device similar to a protractor, while the individual is in the modified Thomas test position (Ehrman, 2013). According to Pescatello in the *ACSM Guidelines for Exercise Testing and Prescription*, the sit and reach test is a valid method for measuring hamstring flexibility, although it is sometimes a poor indicator of lower back flexibility (2014). The test has been found to be practical for the general population (Adegoke, 2012) and also simple to administer (Baltaci, 2003). A disadvantage of the sit and reach test is the belief that the length of an individual's arms and legs can effect the validity of the test's results (Pescatello, 2014; Adegoke, 2012).

There are many different mechanisms for stretching the hamstrings, however, many studies reveal that static stretching is the most effective method for lengthening the hamstring muscles. Static stretching is defined as elongating a muscle to tolerance and sustaining this position for a predetermined length of time. According to Davis (2005), static stretching or static tension is the main proponent for activation of the Golgi Tendon Organ (GTO), which is effective for increasing hamstring length. Nelson (2004) tested the effects of static stretching and eccentric stretching on hamstring flexibility in a six-week study, using males 15-17 years of

age. Results revealed a twelve degree increase in flexibility in the experimental group that participated in static stretching as compared to the control group. Another flexibility study conducted by Davis and associates examined the differences in hamstring flexibility through the use of static stretching, a self-stretch method, and proprioceptive neuromuscular facilitated stretching or PNF (2005). The flexibility programs utilized in this study consisted of 30 second stretches completed three times per week for a total of four weeks. Static stretching elicited greater improvements in hamstring flexibility, as compared to self-stretching and PNF. These studies demonstrate that with regards to hamstrings lengthening and flexibility improvements, static stretching is the preferred method.

Similar studies tested the most duration for holding a particular stretch in order to see greatest flexibility improvements. Different protocols recommend anywhere from five to sixty seconds for stretch duration (Davis, 2005). Bandy and Irion (1997) conducted a study testing static stretches held for 15, 30, and 60 seconds, in order to find the most effective stretch duration. All participants completed the static exercises for five days per week for six weeks. Results exhibited that the stretches held for 30 seconds and 60 seconds showed greater flexibility gains than those of 15 seconds, however there was no significant difference between the 30 second and 60 second group. The *ACSM Clinical Exercise Physiology* (2013) guide recommends that a stretching routine should be completed two to three times per week; however daily stretching is endorsed for optimal ROM. Moreover, static stretches should be held for 10 to 30 seconds. This guide also states that static stretching yields improvements within three to ten weeks in the form of 5 to 20 degrees (Ehrman, 2013).

METHODS

Subjects

Thirty-one students from The University of Akron who were in the Exercise Science Department, have class with the researchers, or simply volunteered participated in this study. All subjects were between the ages of 18 and 37, with an average of age 22 (SD = 3.4). Participants had an average height of 66.7 inches (SD = 2.9) and average weight of 163 pounds (SD = 41.1). All participants were required to fill out a Physical Activity Readiness Questionnaire (PAR- Q) and were apparently healthy. Individuals with pre-existing health or orthopedic conditions that comprise their safety and wellness during physical activity were excluded from participating. An informed consent was also filled out prior to participation. The following documents can be found in appendix B. Approval was given by IRB for the completion of this study.

Procedure

This study was organized with an experimental design with all participants being randomly selected into one of the three groups. The flexibility program was designed based on previous research that designated appropriate yoga based stretches for the quadriceps and hamstring muscles. Peter and Anderson (2007) stated that stretches involving knee flexion and hip extension primarily improve flexibility in the quadriceps muscles. Also, yoga exercises found to lengthen the hamstring muscles were utilized in Donahoe-Fillmore's (2008) flexibility study, which revealed significant improvement in hamstring flexibility after participation in a structured yoga class. Therefore, this information aided in the creation of the flexibility program used in this study.

A pretest was performed on each participant on the first day of the study in order to measure quadriceps and hamstrings flexibility. Prior to obtaining measurements, a five to ten minute warm up was completed on a cycle ergometer at a rate of 50-60 rpm with an average resistance of 1.0kp. Flexibility of the quadriceps muscle was conducted using the modified Thomas test and a goniometer to measure degree of knee flexion. The sit and reach test was utilized to measure hamstring flexibility, using the ACSM protocol. Participants sat on the floor, without their shoes, and placed heels flat against the sit and reach box. Knees had minimal bend and hands were placed on top of one another. The forward stretch was measured twice and then averaged. The same researcher performed flexibility measurements for the same muscle, in order to obtain optimal accuracy.

Subjects were randomly placed into one of three groups: the demonstration, written, or control group. The control group consisted of fifteen individuals (n=15) who were instructed to maintain their normal daily activities throughout the course of the study, which may or may not

include any regular physical activity. The control group was pre-tested for hamstring and quadriceps flexibility during week one of the study and then post-tested in the same fashion during week five. A five to ten minute warm-up was always performed prior to flexibility measurements.

The written instructional group consisted of ten participants (n=10). The written group was pre-tested for hamstring and quadriceps flexibility during week one of the study and then post-tested in the same fashion during week five. A five to ten minute warm-up was always performed prior to flexibility measurements. This group received an instructional brochure, which can be found in appendix A, that included both written and illustrated instructions for performing each of the six stretching exercises designated for this study. Three of the yoga exercises were directed primarily for the hamstrings and three activated the quadriceps muscles. The duration, frequency, and intensity were all stated in the packet. The only instruction given to this group was to complete the program at least two times per week, for four weeks, as well as to record the number of times the program was completed each week. They were asked to perform some form of a dynamic or aerobic warm-up prior to stretching.

The demonstrational supervised group included a total of eight participants (n=8). The demonstration group was pre-tested for hamstring and quadriceps flexibility during week one of the study and then post-tested in the same fashion during week five. A five to ten minute warm-up was always performed prior to flexibility measurements. Upon entering the exercise physiology lab to meet with researchers, this group performed a five to ten minute warm-up on a cycle ergometer, similar to the warm-up performed prior to pre-testing flexibility measurements. The stretches were verbally explained using necessary cues, demonstrated each instance by a researcher, and feedback was continually given to participants regarding proper alignment and form. Each stretch was held for thirty seconds and completed on both sides of the body. A

stopwatch was used to keep track of time. The demonstration, supervised group was also given the informational brochure as another resource. Following the ACSM guidelines for flexibility improvements, this group met twice per week for the duration of four weeks and also given the option to perform the six stretches on their own, in addition to the mandatory two times per week.

After four weeks, a post-test was performed to obtain quadriceps and hamstrings measurements. This was performed in the same manner as the pre-test, including an adequate warm-up period and the methods and procedures for flexibility measurement. The written and demonstration groups were instructed to bring in their logs regarding the number of times they completed the stretching program on their own during the course of the study.

DATA ANALYSIS

Means and standard deviations for each group were calculated. The JMP program was utilized to compare 3 (group) x 1(test) way Anova statistical test, as well as a t test assuming equal and also a t test assuming unequal variances. A one-way Anova was also utilized to compare the gains of the experimental and written groups. Lastly, two one-way Anova was used to compare the pretest measurements from each group, as well as posttest measurements from each of the three groups. The purpose of the Anova between the pretest values for each group was to determine a baseline for all groups. Also, the SPSS program was utilized to execute a paired t-test of the mean values of improvement between pre-test and post-test measurements for each group. Furthermore, a paired t-test was utilized to examine the mean gains for each of the three groups in order to test for significance between the groups. An alpha level of $P < 0.05$ was the level of significance used for both the one way ANOVA and the paired t-tests.

RESULTS

Thirty-one students from The University of Akron completed this research study. Three of the original thirty-six subjects dropped from the study. All subjects were between the ages of 18 and 37, with an average of age 22 (SD = 3.4). Participants had an average height of 66.7 inches (SD = 2.9) and average weight of 163 pounds (SD = 41.1).

Table 1: Pretest, Posttest, and Gain Values for Hamstring Flexibility (cm) for the Control, Experimental, and Written Groups.

	Groups					
	Control (n=15)		Experimental (n = 7)		Written (n=9)	
	Mean	SD	Mean	SD	Mean	SD
Pretest	29.97 cm	7.50 cm	30.43 cm	4.05 cm	30.44 cm	5.09 cm
Posttest	32.43 cm	6.84 cm	33.50 cm	4.80 cm	31.83 cm	6.49 cm
Gains	2.47 cm	2.85 cm	3.07 cm	1.67 cm	1.39 cm	1.96 cm

The table above represents the mean pretest, posttest, and gain measurements for all three groups. The mean pretest and posttest values for the control group were 29.97 ± 7.5 and $32.43 \pm$

6.84. For the experimental group, the mean pretest and posttest values were 30.43 ± 4.05 and 33.50 ± 4.80 , respectively. 30.44 ± 5.09 and 31.83 ± 6.49 are the mean pretest and posttest values for the written group. Upon running a t-test, there was no significant difference between the pretest values between any of the groups, meaning that the participants in each of the three groups entered the study with similar baseline hamstring flexibility.

T-tests: Paired Sample Statistics

Table 2: Paired Samples Statistics for Pre-Test and Post-Test Measurements

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	CPRE	29.9667	15	7.49873	1.93616
	CPOST	32.4333	15	6.84488	1.76734
Pair 2	WPRE	30.4444	9	5.08948	1.69649
	WPOST	31.8333	9	6.49038	2.16346
Pair 3	DPRE	30.4286	7	4.04587	1.52919
	DPOST	33.5000	7	4.79583	1.81265

Table 3: Paired Samples Correlations for Pre-test and Post-test Measurements

		N	Correlation	Significance
Pair 1	CPRE & CPOST	15	.925	.000
Pair 2	WPRE & WPOST	9	.971	.000
Pair 3	DPRE & DPOST	7	.943	.001

Table 4: Paired Samples Test for Pre-test and Post-test Measurements

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 CPRE - CPOST	-2.46667	2.85023	.73593	-4.04507	-.88826	-3.352	14	.005

Pair 2	WPRE - WPOST	- 1.38889	1.96497	.65499	-2.89930	.12152	-2.120	8	.067
Pair 3	DPRE - DPOST	- 3.07143	1.66905	.63084	-4.61504	-1.52782	-4.869	6	.003

Table 5: One-Sample Statistics for Mean Gain Values

	N	Mean	Std. Deviation	Std. Error Mean
C	15	2.4667	2.85023	.73593
W	9	1.3889	1.96497	.65499
D	7	3.0714	1.66905	.63084

Note. C= control group, W=written group, E=experimental group. Gain is defined as the difference between the post-test and pre-test measurements.

Table 6: One-Sample Test for Mean Gain Values

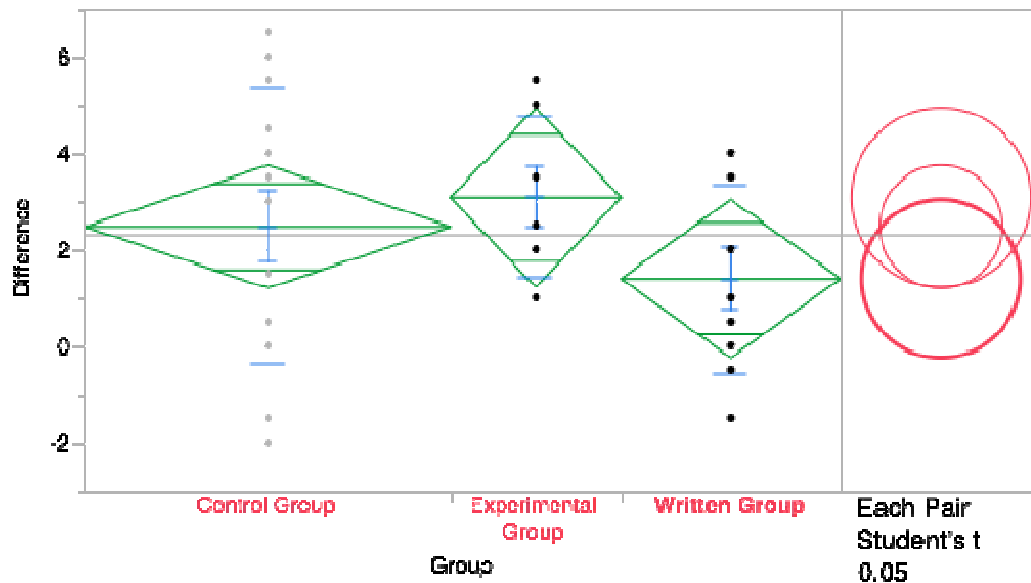
	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
C	3.352	14	.005	2.46667	.8883	4.0451
W	2.120	8	.067	1.38889	-.1215	2.8993
D	4.869	6	.003	3.07143	1.5278	4.6150

Note. C= control group, W=written group, E=experimental group. Gain is defined as the difference between the post-test and pre-test measurements.

Based on the results of the t-tests, the control group showed significant difference between pre-test and post-test measurements ($p=0.05$). More importantly, the experimental group showed significant difference between pre-test and post-test measurements ($p=0.03$). When examining the significance of the mean gains within each group, the control group and experimental group both had significant improvements in hamstring flexibility. Furthermore, the

experimental group had the greatest mean gains (3.07 cm), followed by the control group (2.47 cm) and the written group (1.39 cm).

Figure 1: Mean Gain Differences (cm) between Control, Experimental, and Written Group



Using a one-way Anova, the mean gain differences between the three groups were tested for significant difference. $P=.3648$, which shows no significance between any of the three groups. There was no significant difference between the control group and written group mean gain differences (cm) or the control group and experimental group. Although not significant, the p-value for the experimental and written group was 0.09. The graph below represents this data.

Figure 2: Mean Gain Differences (cm) between Experimental and Written Groups

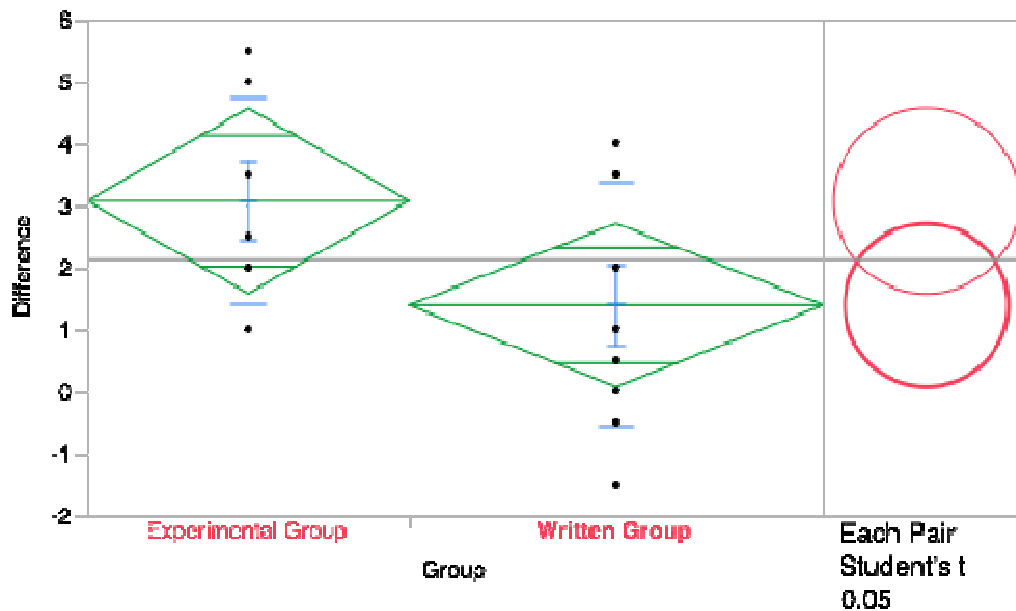
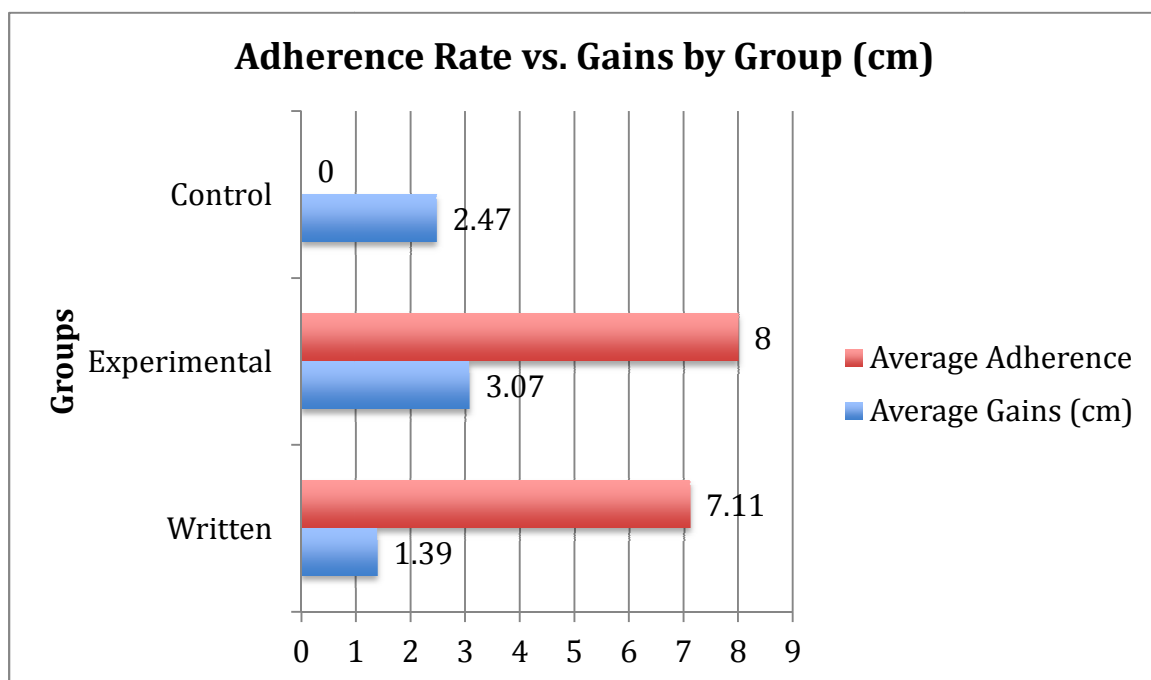


Figure 3:
Adherence Rates
vs.
Flexibility

y Gains for Control, Experimental, and Written Groups



The graph above illustrates the average gains measured from each group in relation to the average adherence rates for each group. The written group averaged 1.39 cm in gains with a standard deviation of 1.96 cm. The experimental group averaged 3.07 cm in hamstring

flexibility gains with a standard deviation of 1.67 cm. The control group showed a mean hamstring flexibility gain of 2.47 cm with a standard deviation of 2.85 cm. The adherence rates are calculated by averaging the number of instances subjects completed the flexibility program during the four-week duration of the study.

DISCUSSION

The purpose of this research study is to compare if instructional techniques affect adherence to a stretching routine. Additionally, the researchers explored if there were improvements in quadriceps and hamstring flexibility. The researchers hypothesize that a combined approach of written, verbal, and demonstrational techniques will elicit greater improvements in quadriceps and hamstring flexibility and exercise adherence than those receiving only written instructions. The experimental group had the greatest mean gains in hamstring flexibility, followed by the control group. The written group had the smallest gains. Results revealed that there was no significant difference between the gains in hamstring flexibility between the control, experimental, or written groups ($P= 0.3648$). The control group had a greater mean gain of improvement than the written group. An explanation for this phenomenon is that the control group did not find importance in their sit and reach measurements until the posttest measurements. Control subjects may have been exposed to their original pretest values, and attempted to improve their score, as it is human nature to strive for improvement. Therefore, based on our results, a four-week static stretching yoga based

flexibility program resulted in significant improvements in hamstring flexibility with a combined approach of written, verbal, and demonstrational techniques utilized with the experimental group ($p= 0.03$) when considering the difference between the pre-test and post-test values.

With regards to the experimental and written groups, there was no significant difference in the mean improvements of hamstring flexibility after the four-week program was implemented when comparing these two groups. However, the experimental group had greatest gains in flexibility among the three groups. Friedrich (1996) and Taheri (2011) found that patient and therapist interaction increased exercise adherence and also improved the quality of the exercises performed, which resulted in significant improvements in pain reduction for the experimental groups versus the brochure groups. The results of this study shadow these findings.

The mean adherence rates of the experimental and written group are similar, 8.0 and 7.11 instances respectively. There was found to be no significant difference in mean adherence rates. However, the self-report method was utilized for the written group, who performed the exercises on their own. Self-report methods are not always accurate, as the subject may wish to enhance their adherence rates when asked directly by a researcher (Berk, 2014). Therefore, it is unlikely that there is a significant correlation between the adherence rates and flexibility gains in this study. Also, it is still uncertain whether or not instructional techniques influence adherence rates, as the simplistic nature of the flexibility program utilized in this study may have been great enough to stabilize the adherence rates between the experimental and written groups. The correlation between adherence rates and improvements in flexibility is rejected as the control group, who never performed the stretching program, had greater gains in hamstring flexibility than the written group and statistically insignificant improvements from the experimental group.

Cuberek (2013), tested the reliability of the sit and reach test as an assessment of flexibility of females. The sit and reach was performed after an eight-minute warm up in

addition to static stretching. Furthermore, Ayala's (2012) study examined validity of the sit and reach assessment in recreationally active young adults. The subjects performed a five minute warm up followed by static stretching for the lower back and hamstrings prior to the sit and reach measurements. Both of these studies, among many others, incorporated a static stretching component prior to sit and reach testing, in order to lengthen muscles of the hamstrings and lower back. Also, Cuberek (2013) and Ayala's (2012) studies found the sit and reach test to be an adequate and accurate form of hamstring flexibility measurement, when administered based on their procedures prior to obtaining measurements. Our study lacked a static stretching element prior to the sit and reach assessment, which may explain the lack of significance in flexibility improvements.

Additionally, Ayala (2012) utilized three practice or trial runs for the sit and reach test a week prior to taking actual measurements, in order to minimize the influence of learning during the pretest measurements. This allowed subjects of all groups to be familiarized with the test and its procedures. Although the pretest measurements obtained for our study show no significant difference between groups, this may have effected the data or posttest data, as each group would have been more familiarized with the sit and reach test during post testing. This may also explain the gains found after four weeks in the control group.

Based on the simplicity of this flexibility program and the results of this study, it is likely that regardless of the instructional method, the gains in hamstrings flexibility are found to be similar among groups. However, as the experimental group had the greatest gains in flexibility, the necessity of feedback, direct instruction, and patient to therapist or instructor interaction demonstrate the importance of adherence or flexibility improvements with regards to the specific program developed for this study. The simplistic nature of the program may explain the similar adherence rates between the written and experimental group, which demonstrates that

completing such program on an individuals own time and within their personal schedule may be just as effective as the instruction and demonstration strategies used by the research team.

LIMITATIONS

The sample size utilized in this study created a limitation for the significance of the data. The female to male ratio was not equal, as there were a much greater number of female participants in the study. It is typical for males and females to have different rates of flexibility; therefore, it is not likely that the results from this study should be applied to both males and females. Another limitation of this study is the age of the participants, which were between the 18 and 37, with an average of age 22 (SD = 3.4). This age group is typically the most flexible, so it may not have been an effective population to examine for a flexibility and stretching study. This is also known as inclusive bias, as the participants in this study were used due to convenience and fit into a narrow demographic range. Furthermore, the majority of the subjects have some degree of knowledge regarding exercise, physical activity, and exercise testing.

Additionally, the pre-test and post-testing measurements from the control group show significant improvements in hamstring flexibility. However, the control group did not complete any flexibility exercises for the study and continued their daily lives, including exercise. Therefore, there should not be a significant improvement in hamstring flexibility for this particular group. This may be due to poor instruction for the sit and reach test, as well as different levels of effort given during the pre-test as opposed to the post-test. The lack of

practice trials for the sit and reach test prior to actual measurements does not account for the influence of learning by the subjects.

A further limitation of the study was subject adherence for both the experimental group and written group, which may have altered the obtained data. It was required that each participant in the demonstration or experimental group meet with the researchers two instance per week, although this was not always the case. The participants were given credit for the completion of the stretching program when they stated it was done on their own time. It is not certain whether or not each individual in the demonstration group completed the program eight times in four weeks. Also, the written group's adherence was based solely on a self-report method, which is likely to be somewhat fabricated.

FUTURE RESEARCH

Future research may examine the effectiveness of a more extensive flexibility program, which expands upon the duration, frequency, and increases the number of stretching exercises performed. Additionally, other populations should be examined, such as those over the age of 65 due to decreased ROM and flexibility with increasing age. With this population, improvements in hamstring and quadriceps flexibility can be examined, but also balance and gait improvements, which are essential elements needed to decrease falls in the elderly population. The typical sit and reach protocol may not be appropriate for the elderly; however, the back-saver sit and reach (BSR) method may be more appropriate.

BSR consists of testing hamstring flexibility with shoes removed, using the same sit and reach box utilized in this study. This protocol is characterized as having a single leg fully extended to the sit and reach box, with sole of foot flat against the box, with the other knee bent and foot resting 2 or 3 inches beside the straight knee. The hands are palm down and

overlapped. Participant is asked to lean forward gradually and push measurement indicator forward. This protocol is said to avoid excessive flexion of the lumbosacral spine in order to protect the lower back (Hartman, 2003). Previous research reveals that the BSR demonstrates similar measurements as a typical sit and reach protocol used on the general population; although, the BSR is less harmful on the lower back (Hartman, 2003). Therefore, future research should examine the elderly population using a more extensive flexibility program to test balance, gait and flexibility improvements using a BSR to alleviate possible strain on the back.

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QUADRICEPS AND HAMSTRING YOGA STRETCH ROUTINE

Perform stretch routine after a 5-10 minute warm up. Warm up may consist of jogging, biking, or any other type of dynamic warm up to prepare the muscles for stretching and avoid injury. All stretches should be taken to the point of slight discomfort, but never any pain. Do this 2-3 times per week for four weeks.



1) Go onto your knees and bring one foot forward with the front knee over the heels.

2) Place both hands on the front thigh and push yourself away as you lean backwards. You should feel this in the front of your leg that is on the floor.

3) Stretch as far as you can comfortably go and hold for 30 seconds. Perform stretch on both legs.



1) Get into the starting position of the first stretch, but move your front leg a little to the side.

2) Lean forward and place both hands on the floor to the inside of your front leg. If your quads are tight you will feel this right away. Hold for 30 seconds and repeat on the other leg.

3) If you need to get a deeper stretch bend your elbows or even place your elbows on the floor.



1) From the second stretch position, keep one hand on the floor and reach back with the other hand (Right hand reaches back to left foot).

2) Twist your body toward your front leg and look up.
Hold for 30 seconds and repeat on opposite leg.

3) If you feel that you can stretch farther, then bring your front hand onto your elbow

2015. *The best yoga poses to improve quad flexibility*. Retrieved from <http://www.mensfitness.com/training/pro-tips/best-yoga-poses-improve-quad-flexibility>.



1) Release hand from foot and reach both hands to front of the mat, shoulder width apart.

2) Bring both legs back and out from underneath the body and place soles of feet as flat as possible onto ground

3) Lift hips into the air until you feel a slight but comfortable stretch in your posterior leg

muscles. Hold for 30

seconds



- 1) Stand with feet shoulder width apart and toes pointing forward.
- 2) Gently let the head, arms, and torso bend forwards over the hips in a comfortable stretch. Bend knees slightly for more comfort.
- 3) Release arms and continue to bend further if you feel you can. Hold position for 30 seconds.



- 1) Stand with feet shoulder width apart and both toes pointing forward. Bring left foot back to a comfortable place and point toes laterally (or outward to the left).
 - 2) While bending over place right hand inside right foot (use a weight or block if reaching to the floor is too difficult. Left hand should point to ceiling.
 - 3) Hold stretch in comfortable position for 30 seconds.
- Repeat for opposite leg.

INFORMED CONSENT

Title of Study: *The Effects of Instructional Strategies on Adherence to an Exercise Program and Physiological Outcomes*

Introduction: You are invited to participate in a research study designed and conducted by faculty and students in the School of Sport Science and Wellness Education.

Purpose: The main objective for this investigation is to compare whether or not different instructional techniques affect adherence to a stretching routine, and if followed were improvements gained in quadriceps and hamstring flexibility.

Procedure: Participants will undergo pretest measurements for hamstring and quadriceps flexibility. The sit and reach test will be used to measure hamstring flexibility. For this test, the participant will sit with their feet flat against a sit and reach box and lean forward as far as comfortable possible. The quadriceps will be assessed using the modified Thomas test. The participant will lie on their back at the edge of a table with one leg tucked close to their chest and their dominant leg hanging off of the table. While in this position, a goniometer will be used to measure knee flexion of the dominant leg. Participants will be randomly assigned to a control group, written instruction group, or a supervised demonstration group. To maintain anonymity, participants will be assigned a pseudo name for the study. The control group will be asked to go about their typical day and continue with any current exercise activities that they may perform. The written instruction group will be provided a packet for a yoga stretch routine and will be asked to perform the routine on their own 2-3 times per week for 4 weeks. The supervised demonstration group must meet with the researchers twice a week for the 4 weeks to perform the routine. They will be guided through the poses and provided feedback on correct form. At the conclusion of the 4 weeks, a post test will be conducted to assess changes in flexibility. The post test will be conducted in the same manner as the pre-test.

If you agree to have your information used as part of the research data, you will be asked to sign this informed consent document.

Inclusion: All apparently healthy individuals are able to participate in this study.

Exclusion: Individuals with a pre-existing health or orthopedic conditions that compromises their safety and wellness during an aerobic warm up and/ or stretching. In order to exclude any ineligible participants, all participants will be required to fill out a Physical Activity Readiness Questionnaire (PAR-Q).

Risk and Discomfort: Minimal discomfort may be experienced during the stretching process.

Benefits: Participating in this study will allow you to experience a unique stretching routine that may improve flexibility. Knowledge may be gained about proper stretching form as well as the benefits of consistently following a stretching routine. By participating in this study, you may add this to your resume. Your participation will also help us gain information about effective instructional strategies for improving physiological measurements.

Payments for Participation: No monetary compensation will be given for participating;

Right to refuse or withdraw: Participation in the research is voluntary. You may withdraw consent and discontinue participation in the study at any time without any consequence to you.

Anonymous and Confidential Data Collection: All information will be coded with a pseudo name. Only the principal investigator and co-principal investigator will have access to the data. As a participant, you will not be individually identified in any publication or presentation of the research results. Only aggregate data will be used. To insure your privacy, the information found in this study will be subject to the confidentiality and privacy regulations of The University of Akron.

Confidentiality of records: All information will be coded and stored in a password protected database. No identifying information will be in the database. The principal investigator will keep the code key connecting your name to your pseudo name in a separate locked file.

Who to contact with questions: If you have any questions at any time, you may contact Rachele M. Kappler at 330-972-6524. This project has been reviewed and approved by The University of Akron Institutional Review Board. If you have any questions about your rights as a research participant, you may call the IRB at (330) 972-7666.

Thank you for your willingness to participate in this study.

Rachele M. Kappler, M.S.Ed.
Peter Waisala
Taylor Graham

Signature_____

Date_____

Appendix C

Physical Activity Readiness
Questionnaire - PAR-Q
(revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
<input type="checkbox"/>	<input type="checkbox"/>	1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?
<input type="checkbox"/>	<input type="checkbox"/>	2. Do you feel pain in your chest when you do physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	3. In the past month, have you had chest pain when you were not doing physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
<input type="checkbox"/>	<input type="checkbox"/>	5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
<input type="checkbox"/>	<input type="checkbox"/>	7. Do you know of <u>any other reason</u> why you should not do physical activity?

If
you
answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.

- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- if you are or may be pregnant — talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____

DATE _____

SIGNATURE OF PARENT
or GUARDIAN (for participants under the age of majority) _____

WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.



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